

# **NSF Ideas for Future Investment**

## **The “Big Ideas” Summarized**



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**MPS Advisory Committee  
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# NSF Ideas for Future Investment - “Big Ideas”

SCIENCE POLICY

Science

MAY 12, 2016

## *NSF director unveils big ideas*

Plan is aimed at the next president and Congress

**“This comes at a time of transition,”** she told the National Science Board, NSF’s oversight body, on 6 May. “So that makes it **a great opportunity for NSF to present a menu of the things it can do.**” And NSF’s current budget of \$7.46 billion is insufficient to tackle these questions, Córdova told *Science* after the meeting. “We can’t do any of these things without future investments. **So yes, we need an infusion of money.**”



## Research Ideas

### Harnessing Data



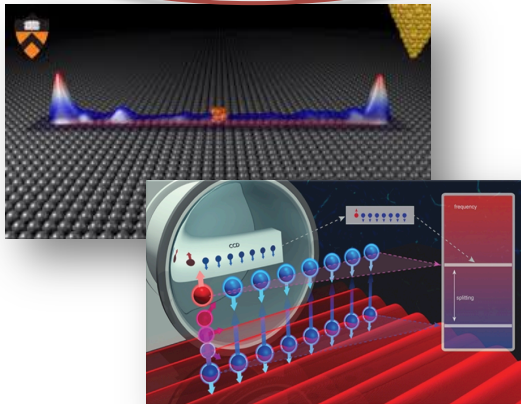
### Human-Tech Frontier



### Rules of Life



### Quantum Leap



### New Arctic

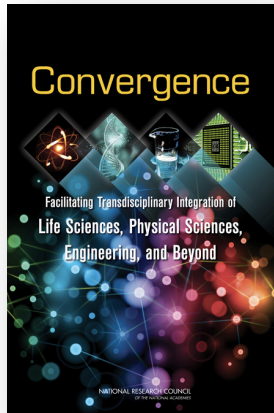


### Windows on the Universe



## Process Ideas

### Convergence



### Mid-scale



### NSF 2050 Fund



### INCLUDES



Mathematical and Physical Sciences



# Research Ideas

## Harnessing Data



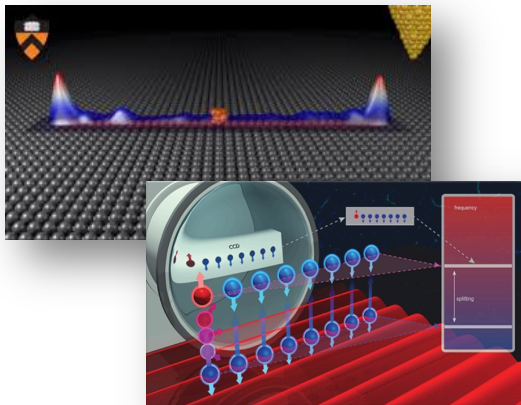
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# NSF Ideas for Future Investment - “Big Ideas”

## Harnessing Data for 21st Century Science and Engineering



*“engage NSF’s research community in the pursuit of **fundamental research in data science and engineering**, the development of a cohesive, federated, national-scale approach to **research data infrastructure**, and the development of a **21st-century data-capable workforce**.”*



# Harnessing Data for 21st Century Science and Engineering



## Engagement of research domains

## Learning opportunities and pathways



# NSF Ideas for Future Investment - “Big Ideas”

## Shaping the New Human-Technology Frontier



*“catalyze the interdisciplinary science and engineering needed to shape that future and the **human centered engineered and social systems** that those technologies will enable .”*



# NSF Ideas for Future Investment - “Big Ideas”

## Understanding the Rules of Life: Predicting Phenotype



*“How do living systems, from cells to organisms, get to be the way they are (the “**phenotype**”) through the complex **interplay of the information** contained in the **genetic blue print** (the “**genotype**”) and the **environment** .”*

# NSF Ideas for Future Investment - “Big Ideas”

## Understanding the Rules of Life: Predicting Phenotype



*Computational modeling and informatics*

*Understanding genetic, epigenetic, and environmental factors*

*Predicting behavior of living systems*

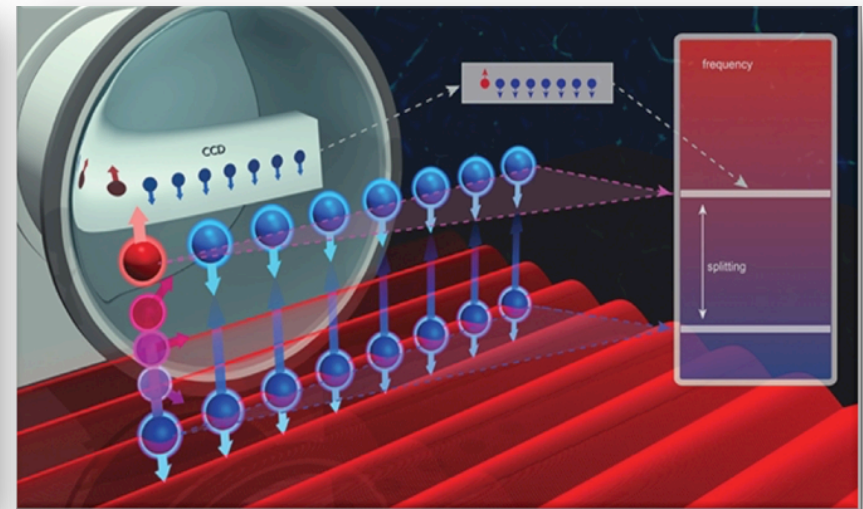
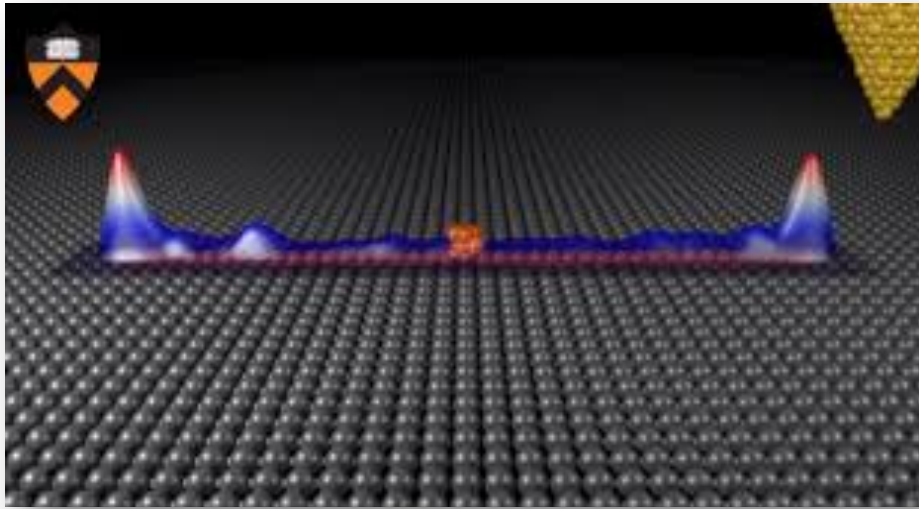
*Influence of the symbiosis with microorganisms*

*Ability to synthesize cells and organisms from basic molecules*



# NSF Ideas for Future Investment - “Big Ideas”

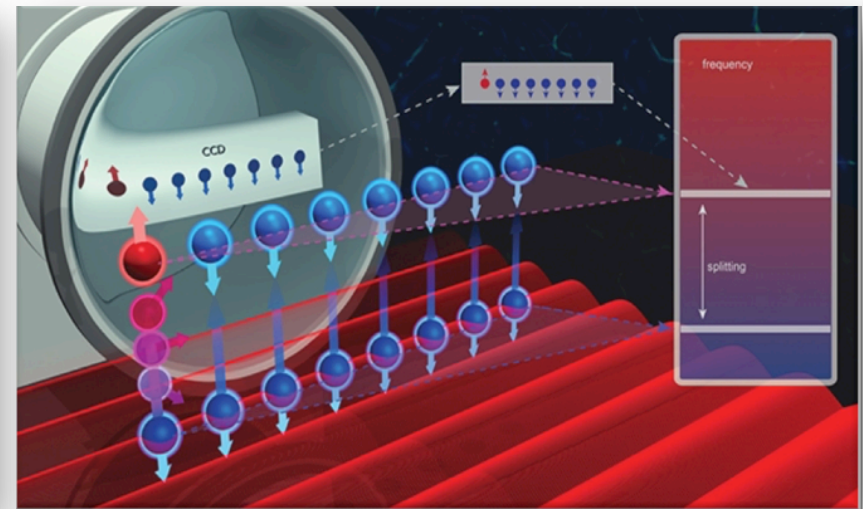
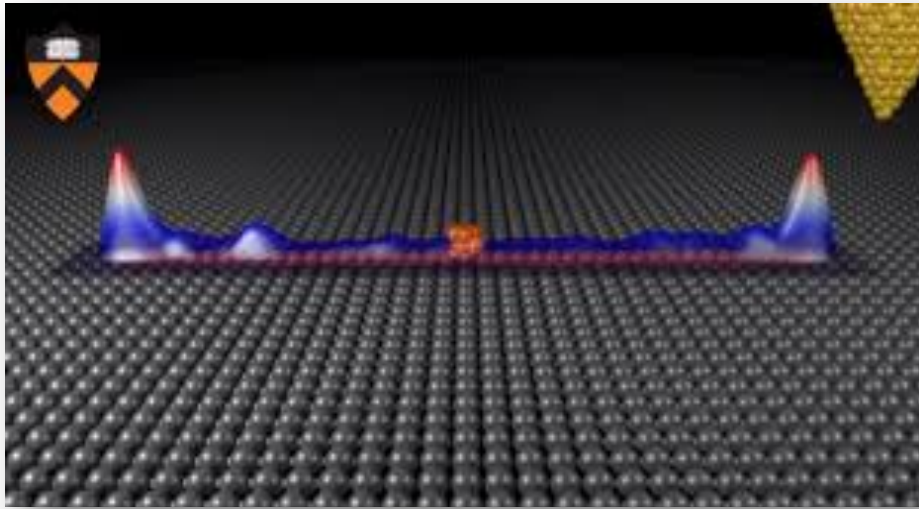
## The Quantum Leap: Leading the Next Quantum Revolution



*“a cross-NSF approach to identifying and supporting research that answers deep questions about quantum behavior and develops the means of accessing and manipulating quantum systems ... couple together experiment, computation, and theory to attack fundamental questions”*

# NSF Ideas for Future Investment - “Big Ideas”

## The Quantum Leap: Leading the Next Quantum Revolution



*Preparation and manipulation of complex or dynamic quantum states*

*Control light-matter interactions to create new quantum phenomena*

*Mathematical descriptions of emergent quantum behavior*

*Design and engineer systems to use quantum effects extensively*





# NSF Ideas for Future Investment - “Big Ideas”

## Navigating the New Arctic



*“establish an observing network of mobile and fixed platforms and tools across the Arctic to document these rapid **biological, physical, chemical and social changes**, leveraging participation by other federal agencies”*



# NSF Ideas for Future Investment - “Big Ideas”

## Windows on the Universe: The Era of Multi-messenger Astrophysics

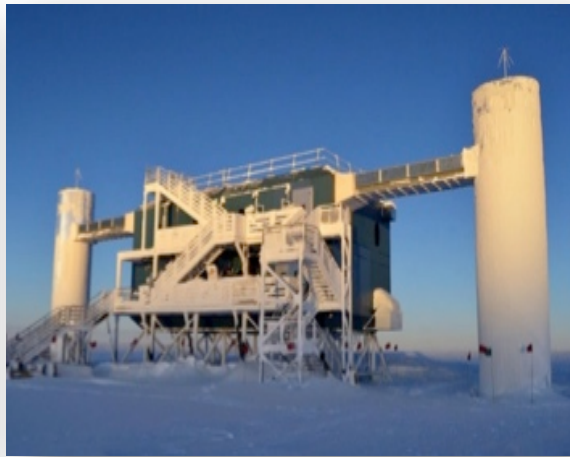


*“observe the universe and extreme events in it through three different windows – detection of **electromagnetic waves, particles, and gravitational waves** – to answer some of the most profound questions before humankind”*



# NSF Ideas for Future Investment - “Big Ideas”

## Windows on the Universe: The Era of Multi-messenger Astrophysics



*How did the universe begin?*

*Why is the universe accelerating?*

*What is the unseen matter that constitutes much of the universe?*

*How does gravity work under the most extreme conditions?*

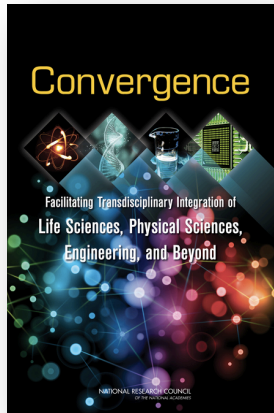
*What are the properties of the most exotic objects in the universe?*





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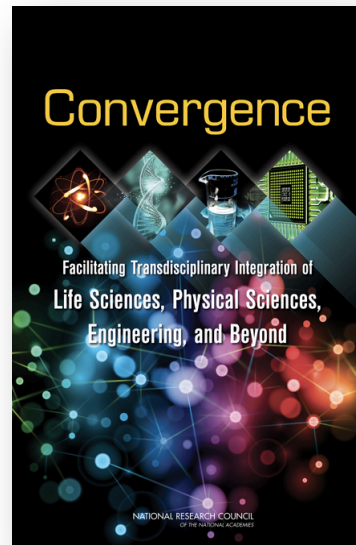
Mathematical and Physical Sciences





# NSF Ideas for Future Investment - “Big Ideas”

## Growing Convergent Research at NSF



*“the convergence paradigm **augments a more traditional transdisciplinary** approach to research by framing challenging research questions at inception, and fostering the collaborations needed for successful inquiry”*

*“motivated by intellectual opportunity or important society problems”*



# NSF Ideas for Future Investment - “Big Ideas”

## Mid-scale Research Infrastructure



*“meet the need for **large, mid-scale research infrastructure** for science and engineering that is changing to*

- rely on cyberinfrastructure, broadly defined,*
- be diverse in space, cost, and implementation time, and*
- require dynamic and nimble responses to new challenges”*



# NSF Ideas for Future Investment - “Big Ideas”

## NSF 2050 The Integrative Foundational Fund



*“a **fund** dedicated to identifying bold, **long-term foundational research questions** to set the stage for breakthrough science and engineering all the way to NSF’s Centennial in 2050”*



# NSF Ideas for Future Investment - “Big Ideas”

## NSF INCLUDES: Enhancing Science and Engineering through Diversity



*“NSF INCLUDES: ‘Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers’ **invests in alliances using collective impact-style approaches** ... to achieve inclusion in science and engineering, at scale, of people from traditionally underrepresented groups”*





# Research Ideas

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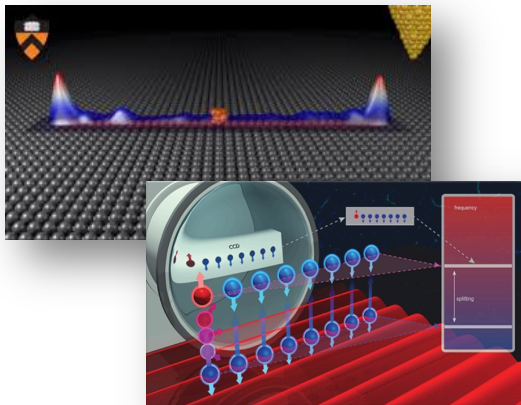
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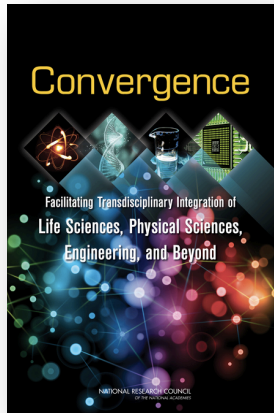
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## Next Steps

**Working Groups to Plan for  
FY 2017, FY 2018, and beyond - differing by topic**

- Establish baseline of current investment
- Community input – workshops, ...
- New programs, new coordination, meta-programs, ...

## Thoughts and Comments

